HOW TO TEACH

BUGS, BEETLES, AND LOCUSTS

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No. 8.

BY

FRANK OWEN PAYNE

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BY

FRANK OWEN PAYNE

AUTHOR OF "ONE HUNDRED LESSONS IN NATURE AROUND MY SCHOOL," "HOW TO TEACH MINERALS," "HOW TO TEACH BIRDS"

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ROBERT DRUMMOND, PRINTER, NEW YORK

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CHAPTER I.

What is an Insect?

An insect is an animal whose body is composed of rings or joints (*articulate*); having jointed feet (*arthropod*); having the body more or less distinctly divided into three parts (*head*, *thorax*, and *abdomen*); and always having *six* legs attached to the middle part of the body.

An insect usually has four wings also attached to the thorax, but there are many species of insects which have only two wings and some have no wings at all.

Insects usually have compound eyes, which consist of a vast number of separate lenses; and some insects have one or more single eyes (*ocelli*) elsewhere upon the head.

It is well to have in mind a clear idea of what an

insect is, for many people are wont to consider other creatures as being insects. The spider, the scorpion, the sow-bug, the centipede, and the millipede, though they are commonly classed as insects, are not any of them true members of that class of animals since they do not have *six* legs.

A casual glance at a spider will at once convince any observer that this creature can not be classed with true insects, if the foregoing definition is correct. His *two-parted body* and *eight legs* at once put him in another category.

In general, any animal which has a *three-parted body* and *six legs* is an insect.

CHAPTER II.

The Parts of an Insect.

THE main parts of an insect have been given as *head*, *thorax*, and *abdomen*. Let us consider these parts with reference to their special features.

1. **The Head.**—This is of various shapes and sizes. It may be firmly attached to the thorax without any apparent neck or there may be some appearance of a neck. In many insects the head is attached to the thorax by a mere thread. This is true of the dragon-fly and the house-fly. The head may be moved freely from side to side. It is easily detached. The head bears various appendages among which may be mentioned the eyes, ocelli, antennæ, mouth-parts, and various hairs, bristles, etc.

2. **The Thorax.**—This seems to be a very important part of the body. It possesses a wonderful system of muscles for manipulating the six legs and four wings of the insect. It is made up of three rings or segments. These rings have names which need not be taught to children. They are (*a*) the prothorax, bearing the first pair of legs (prolegs),

(*b*) mesothorax, bearing the first pair of wings and the second or middle pair of legs (mesolegs), and (*c*) the metathorax, bearing the second pair of wings or hind wings and the third pair of legs (metalegs).

3. **The Abdomen.**—This is the hinder part of the body. It usually shows the rings very distinctly. Along the sides are small pores (spiracles) through which the insect breathes.

The abdomen sometimes is beset with hairs or bristles, but the most important appendage is the *ovipositor*, which terminates the abdomen of a female insect. It is by means of this organ that the eggs are laid.

CHAPTER III.

The Mouth-parts.

WE do not speak of the *mouth* of an insect. An insect has no mouth in the same sense that higher animals have mouths. Students of insects speak of the *mouth-parts*, because the mouths of insects consist of various parts quite separate and independent of each other. Here is a drawing of the mouth-parts of a common grasshopper. Any pupil can find these and remove them one by one with a penknife. The insect should be killed first in a cyanide bottle and preserved in a solution of formaldehyde or alcohol until ready to use. As each mouth-part is removed, it should be laid upon a card in the relative position it held before having been removed. Each part can then be studied by itself.

These parts are: (1) an upper lip (labium) which hangs down over the other mouth-parts somewhat like an apron, partly concealing them. Just behind this come two hard-toothed organs called mandibles which are used for tearing or chewing the food. Next come the maxillæ, each armed with a jointed

feeler (maxillary palpus), and last of all the lower lip or labium also bearing a pair of palpi.

Any one who watches a grasshopper when feeding will be interested and amused. The maxillary and labial palpi help to pass the food inward between the mandibles which crush it. The most interesting thing about the mouth movements is the fact

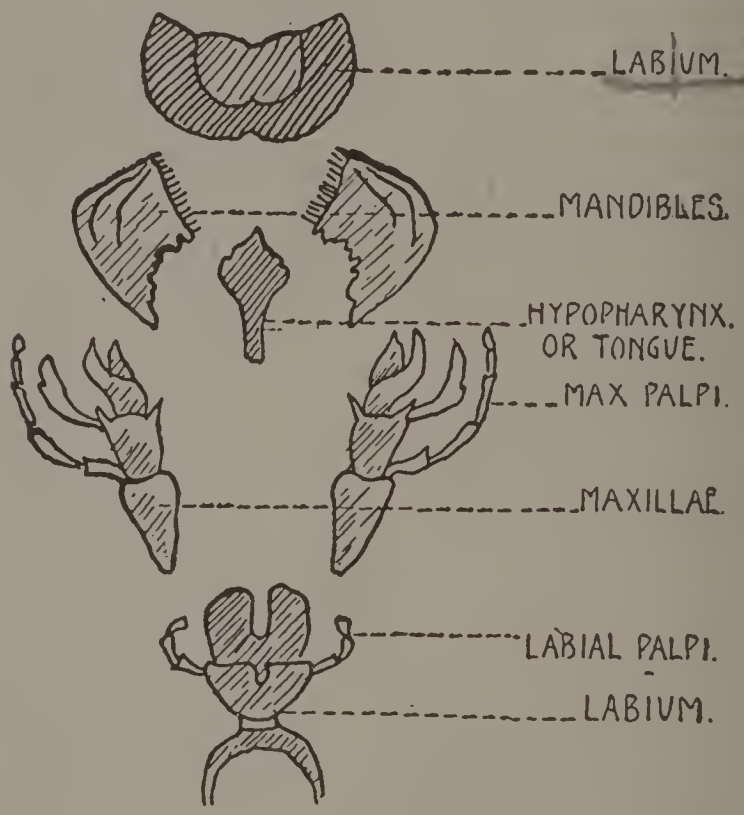

FIG. 1.—Mouth-parts of Locust.

that the mouth-parts move from right to left instead of up and down as in higher animals.

But not all insects have their mouths composed of such curious parts. Such mouths are found only in insects which chew their food. But those whose food is liquid have no need of jaws and mandibles. Hence in these insects the mouth-

parts are so modified as to fit them for sucking. In fact, in some insects the mouth-parts are changed and fused into a tube which is used for extracting the nectar from flowers or blood from animals.

The so-called *proboscis* of the moths and butterflies is such a mouth.

CHAPTER IV.

Legs and Wings.

THE legs of insects are jointed. Every joint has its own special name, and since these are not hard to learn, they are given here. Beginning at the body, the first joint is called the *coxa*. This is usually round or nearly so, as in outline. Next to the coxa is a joint which is always smaller in size. It is called the *trochanter*. The third joint is the *femur*, which is followed by the *tibia*, and this in turn by the *tarsus*. These last names are so familiar from the study of physiology that it will be easy to remember them. There are always or nearly always hooks on the last tarsal joint. Catch a June-bug and see how he holds on with these hooks when one attemps to remove him from one place to another. The legs of insects serve various uses. They may be used for

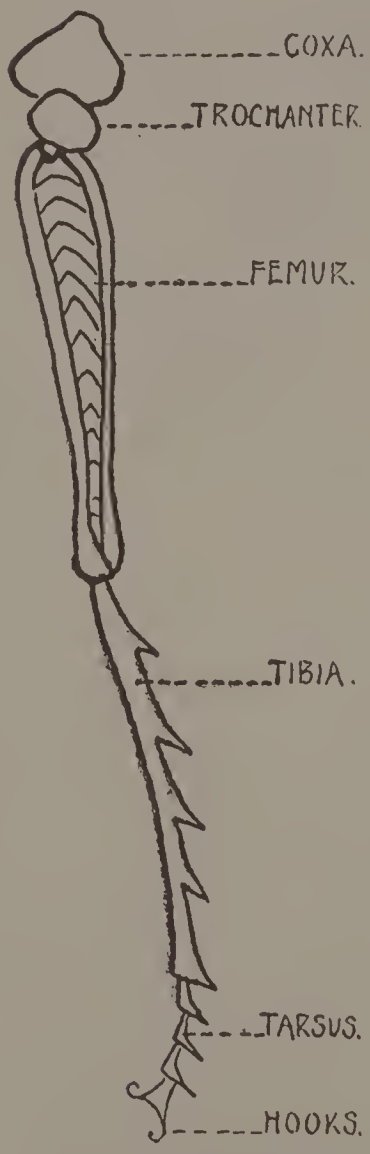

FIG. 2.—Leg of Grasshopper.

walking, jumping, clinging, catching prey, digging, etc.

The wings of insects vary greatly. The peculiarities of the wings are very important in deter-

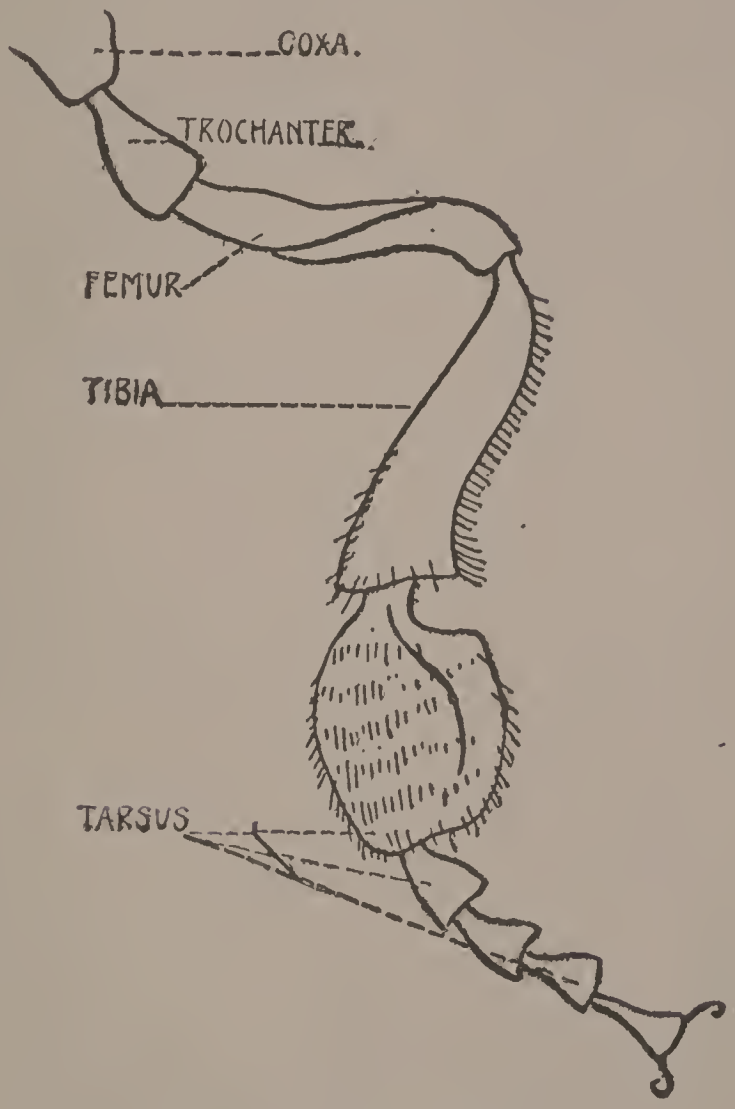

FIG. 3.—Leg of Bee.

mining the order to which an insect belongs. Insects may be wingless or two-winged or four-winged. These wings may be *lace-like* as in the dragon fly; *shell-like* as in the beetle; *membranous*

as in the bee; *straight* as in the locusts; *scaly* as in the butterflies, moths, etc. Running through the wings are "veins" which give a sort of framework to the wing and also convey air and blood and are supposed to assist in purifying the blood.

CHAPTER V.

How to Catch and Kill Insects.

EVERY pupil who intends to study insects should provide himself with the following apparatus:

1. Insect-net.
2. Cyanide bottle or bottle of gasoline.
3. Plenty of pins; ordinary will do. Regular insect pins are preferred.
4. Several empty cigar-boxes, lined with sheet cork.
5. A bottle of alcohol or formaldehyde solution, for preserving soft specimens.

FIG. 4.—Insect-net.

The insect-net is nothing more than a thin muslin or cheese-cloth bag, usually conical in shape and having a hem around the top. Into this hem is thrust a piece of stiff wire.

This wire having been bent into a hoop, is fastened firmly to the end of a stick, preferably a broom-stick, perhaps four feet long. The bag should be loose enough to fit over a wire hoop 8″ or 10″ in diameter.

The net is to be used in catching insects on the wing.

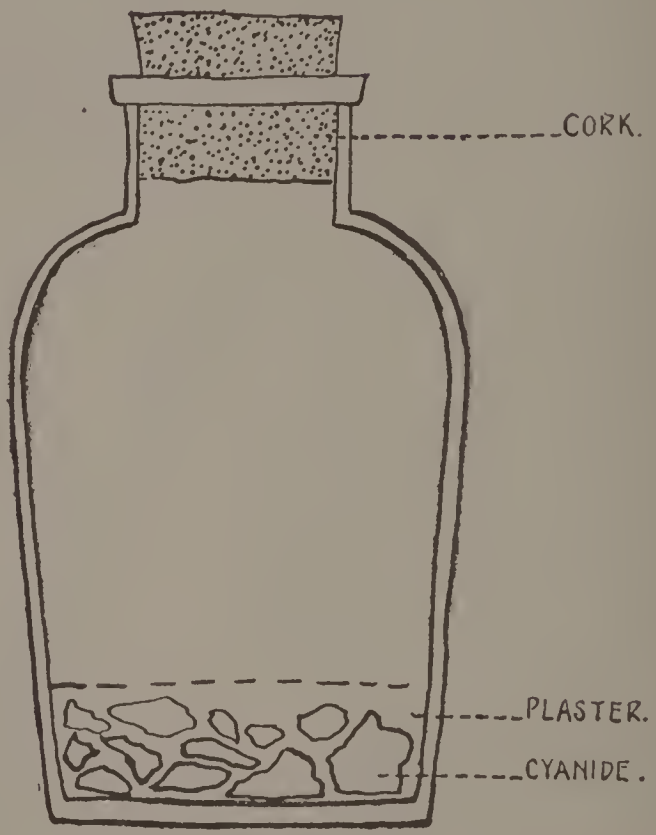

FIG. 5.—Cyanide Bottle.

2. The cyanide bottle is any large bottle having a wide mouth into which is first put several fragments of potassium cyanide and then these fragments are covered with a cream of plaster of Paris. When the plaster has hardened, the superfluous moisture should be wiped out with blotting paper.

The writer uses for this purpose a quart jar (Mason jar) having a cover which screws on.

3. The pins are for fastening the insects to a box.

4. Empty cigar-boxes are to receive the dead specimens.

5. The alcohol or formaldehyde is for preserving soft specimens. The gasoline is used to kill insects quickly, also for ridding cases of insect pests. A few drops of gasoline or naphtha sprinkled on an insect will kill it immediately. Care should be exercised in killing insects in this way for the death agony causes certain insects, as butterflies and moths, to pull their wings in front or below the body.

CHAPTER VI.

Beetles.

On account of their abundance and the ease with which they are captured, beetles are about the best insects to begin with. They may almost always be found in rotten wood, under stones and boards which have been lying long on the ground. There are also some nocturnal beetles, like the well-known "June-bug," which are attracted into houses by the light on summer evenings.

Fig. 6.—A Grub.

Let us take this familiar beetle as a type for study.

1. The head: small, oval; eyes large; antennæ short, bent inward; mouth-parts fitted for biting.

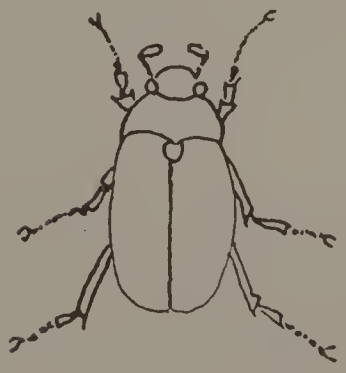

Fig. 7.—A Beetle.

2. The thorax: smooth, shining, its three segments completely fused together. Legs armed with hairs; toes hooked; wings 4, the upper pair (elytra) being shining horny and used merely as covers for the under thin gauzy pair. Line separating elytra straight.

Fig. 8.—Side View.

3. Abdomen: oval, jointed, brown. Spiracles small.

4. Natural history: (*a*) Eggs laid on the ground among short grasses. (*b*) Eggs hatch very soon into small white grubs having brown heads. These at once burrow into soil and begin feeding on roots of grasses. (*c*) Larvæ grow very slowly all summer and go down deeper on approach of winter. In spring they again come up near the surface and feed all the summer as the common white grubs found in spading and plowing. (*d*) In the second fall they form a round or oval cavity in soil and there spin their cocoons. (*e*) They become perfect beetles before spring but remain in the ground until spring when they dig their way out and fly about. Their flight is noisy on account of the resistance of the air to their elytra.

THE POTATO-BEETLE.

The Colorado potato-beetle must not be confused with the old-fashioned "potato-bug." The latter is not a beetle at all, as will be seen at a glance. Its wings are very different. The potato-beetle is similar in structure and shape to the May-beetle or "June-bug," but it is much smaller, and is very different in appearance. It is justly cele-

FIG. 9.—*A*, Elytron; *B*, Potato-beetle.

brated for the great damage it does to the potato-crop and for the wonderful way it has spread during the past twenty-five or thirty years. In that time it has covered an area of over 1,500,000 square miles.

The wing-covers (elytra) are striped with dark brown and yellow. The true wings are rose color. This insect is so common now that it may be seen and observed by everybody.

The life-history is briefly as follows: (*a*) Eggs of a bright orange color are laid on the under surface of potato leaves. (*b*) These soon hatch, and the grub is small, of orange color, with dark brown head. These larvæ grow rapidly, and eat the potato foliage with relish. Their bodies are very soft, only the upper end being hard. (*c*) When full grown, the larva digs into the ground, and in about three weeks has passed through the pupa state. (*d*) The imagos come from the ground, lay their eggs, and the same changes are repeated. There are always two, and sometimes three, broods produced every summer. The last imagos remain all winter in the ground as "seed" for the next season.

This interesting beetle, as its name implies, was originally a native of Colorado and the Rocky Mountain States. It fed on a wild potato plant. But having learned to like the cultivated potato, it began to follow that crop eastward. Paris-green is the poison commonly used to rid the farms of these pests.

THE LADY-BUG.

This is a favorite insect. It is often known as the "lady-bird" or "lady-bird-beetle." Lady-beetles may be known by their handsome elytra, which are black, with scarlet or yellow dots; or scarlet or yellow, with black or brown dots. In shape they are almost perfect hemispheres, and their shining wing-covers are so smooth as to make it rather difficult to pick them up. When disturbed, they emit a very disagreeable odor, which is designed as a protection against enemies. The lady-bug passes through its changes in a manner quite peculiar to itself. When ready to change, it fastens its abdomen firmly to a twig or leaf.

The lady-beetles are friendly to the plants. In this they are quite unlike the potato-beetle, which destroys acres of potato plants, if let alone. The food of the lady-beetle is plant-lice. Thus, by feeding on the enemies of the plants, these beautiful insects prove themselves among the best friends of the plants.

It is a very interesting sight to see a lady-beetle seize and devour the plant-lice which infest most of the plants of our gardens.

Many people ignorantly kill lady-beetles, because they find them on the rose-bushes and other plants in summer.

The lady-beetle also has enemies. The most interesting one is a parasite, which lays its eggs upon

a lady-beetle. These eggs hatch and gnaw their way into the abdomen of the beetle. Here they feed until they are full grown. Then they burrow out and spin their tiny cocoons. The beetle seldom lives long after this, and the parasite soon comes forth, spreads its wings and flies off in search of some other lady-beetle on which to lay its eggs.

This parasite looks not unlike a tiny hornet, and belongs to the same family of insects.

THE SNAP-BEETLE OR CLICK-BEETLE.

This curious and interesting beetle is quite common. It is the largest of snap-beetles or click-beetles. It is of a dull gray color and has two velvety-black oval spots on the thorax. These give this beetle a hideous look. The head is very small and scarcely visible under the thorax. The antennæ are long and jointed, being very different from those of the beetles previously studied.

FIG. 10.—Snap-beetle or Eyed Elater.

The name "click-beetle" is due to its peculiar behavior when placed on its back. It gives a quick movement of the thorax accompanied by a sharp clicking sound and throws itself upward, usually coming down right side up. Click-beetles are not all like this one. Most species are black or dark brown in color. Some have conspicuous ridges running down the wing-covers.

In the larval state, the eyed elater lives in rotten wood. The other click-beetles live either in decaying wood or in the soil where they feed on the roots of grasses and other plants. Indeed, some of these do much harm to crops of wheat, oats, corn, etc. These larvæ are known as wireworms because of their slender, wiry bodies. Their heads are brown and bodies yellow or creamy-white in color. Click-beetles do not reach maturity in one season; on the contrary they are known to take three or four years to reach the perfect state.

TIGER-BEETLES, BORERS, AND SOLDIER-BEETLES.

The tiger-beetles are very unlike the lady-beetles. The head is very conspicuous. The thorax is also well-marked and the abdomen much wider than the other parts. The elytra are black or dark greenish-brown, variously marked with yellow. Tiger-beetles are very active and intelligent in their actions. When approached they will permit one to come very close and then fly quickly away for several feet. In alighting they always face the approaching person so as to keep him well in view. Tiger-beetles burrow in the ground. Their larvæ hide there and thrust out only the head, which is not easily seen because of its dirt-color. The larva is also said to have a curious hook on one of the rings of the abdomen for holding him fast in his hole if some enemy should attempt to pull him out.

The boring-beetles resemble the tiger-beetles in

color and in the yellow V-shaped markings on their wing-covers. The borers, as their name implies, bore into trunks of trees. Thus there is the apple-tree borer, the hickory-tree borer, the locust-tree borer, etc. The larvæ have no feet. Their mouth-parts are very highly developed, their teeth being very sharp and hard. Thus they can easily bore into the hardest kinds of wood.

The soldier-beetles are bright, handsome fellows in uniforms of black and yellow. They are always more or less numerous on the blossoms of the goldenrod. These beetles are always in motion and they fly well.

WATER-BEETLES.

Nowhere among insects is the adaptation of parts to environment better shown than in the water-beetle, or water-scavenger, as this curious beetle is called.

The body is almost a perfect oval, being slightly pointed at the posterior end. The head is large and the eyes are rather prominent. The antennæ are very curiously built, being club-shaped and small and almost hidden under the eyes. The maxillary palpi are long and look somewhat like antennæ at first sight.

The shell and wing-covers are bright, shining black or dull brown. The legs are flat and paddle-like. They are armed with long hairs or bristles.

These legs are used as oars to paddle through the water or over it.

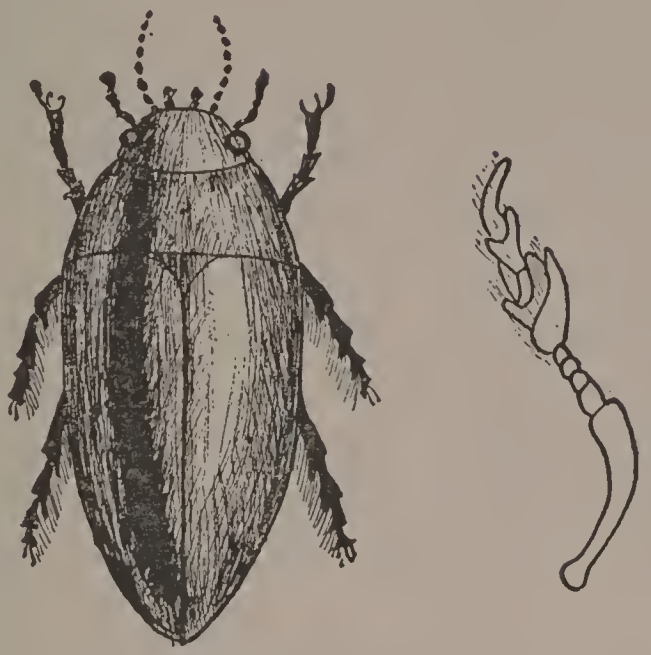

FIG. 11.—Water-beetle ; antennæ.

This fine beetle is a good diver as well as an excellent swimmer. The eggs are laid in delicately-woven egg-cases, which are fastened to the leaves of submerged plants.

The larvæ live in the water. They may be easily reared in aquaria, where they may be seen to swim and dive after their prey.

FIG 12.—A Water-beetle.

The legs of many water-beetles are not conspicuous, especially when they are swimming, but when viewed from below as they swim over the surface of the water of an aquarium, it will be seen that they use their paddle-like feet with great rapidity.

CARRION-BEETLES AND SEXTON-BEETLES.

Nature provides for the removal of offensive decaying animal matter, such as dead animals. One of these provisions for removing such offensive objects is the carrion-beetles (silpha) and sexton-beetles (necrophorus).

Carrion-beetles are distinguished by their black, flat bodies and their club-shaped antennæ. Their flat bodies enable them to creep into very narrow crevices and to crawl under almost any object which may be lying on the ground, such as a dead mouse.

The sexton-beetles are rather larger than the carrion-beetles and have their elytra variously cross-striped with a bright orange-red or brick-red color. Sexton-beetles are so called because they bury the carrion by undermining it so that it falls into the hole. Then they lay their eggs on it, and when these hatch the larvæ find an abundance of food on which to feed. Having reached their full size they burrow in the ground forming an oval cavity, in which they pass their pupa state; after which they emerge from the soil to hunt a choice bit of carrion on which to lay their eggs.

The amount of labor performed by these insects in burying dead animals is tremendous, when compared with the size of the insect itself. The relative strength of insects is very great, as may be seen in these beetles as well as in ants and some other insects.

CURCULIOS OR WEEVILS.

Did you ever find a "worm" or tiny white grub inside a cherry, close to the stone? Did you ever see plums, peaches, apricots, nectarines, and other drupes or stone fruits ripen before their time and drop from the tree? Plums are especially apt to do this; and prunes, unless very carefully guarded, will wither and fall from the trees. This is due to the sting of an insect known as a weevil or curculio.

FIG. 13.
A Weevil.

This curious beetle is very unlike those previously studied, in many respects. 1. The head is long, prominent, and almost straight; eyes small; antennæ long and reflexed or turned back in all ordinary attitudes of the insect. 2. The thorax is almost spherical, being broadly egg-shaped. 3. The abdomen is very much wider than the thorax, and springing outward at right angles to it. This insect has a shape not unlike a bottle or vase. The wing-covers are variously mottled and ridged.

If one of the plums previously mentioned be examined, a scar or wound will be found upon it. This wound is a puncture nearly surrounded by a crescent-shaped cut. This cut is made by the peculiar mouth-parts of the parent weevil, for the mouth here also performs the office of ovipositor.

Some species have such powerful mouth-parts as to enable them to bore through the shells of nuts and lay their eggs there.

Specimens of weevils in all these stages should be obtained and preserved in formaldehyde or alcohol. To obtain the insect imagos, spread a sheet or other large cloth on the ground under an infested tree, and shake or thump it vigorously. The weevils will fall to the ground and feign death. Larvæ will be found in the stung fruit, and if some of these be placed on damp soil in a box, the full-grown larvæ will creep out and bury themselves in the soil to pass their pupa stage. Specimens of this sort should also be preserved with the larvæ and perfect beetles.

SOME STRANGE BEETLES.

In concluding this portion of the work let us consider a few remarkable beetles.

1. The firefly. This is a very inconspicuous little beetle having an oblong body of dark dull yellow and black. By day it flies little, but spends most of its time resting in the shade of bushes and low plants. Some species never become completely developed into imagos, hence they are called "glow-worms."

Just what causes the light of these insects, has not been satisfactorily determined. The majority of scientists believe that this light is due to the oxidation of some gas emitted by the spiracles or

tracheæ. There are many species of luminous beetles, some living in Mexico and Central and South America give brilliant light and are used instead of lamps.

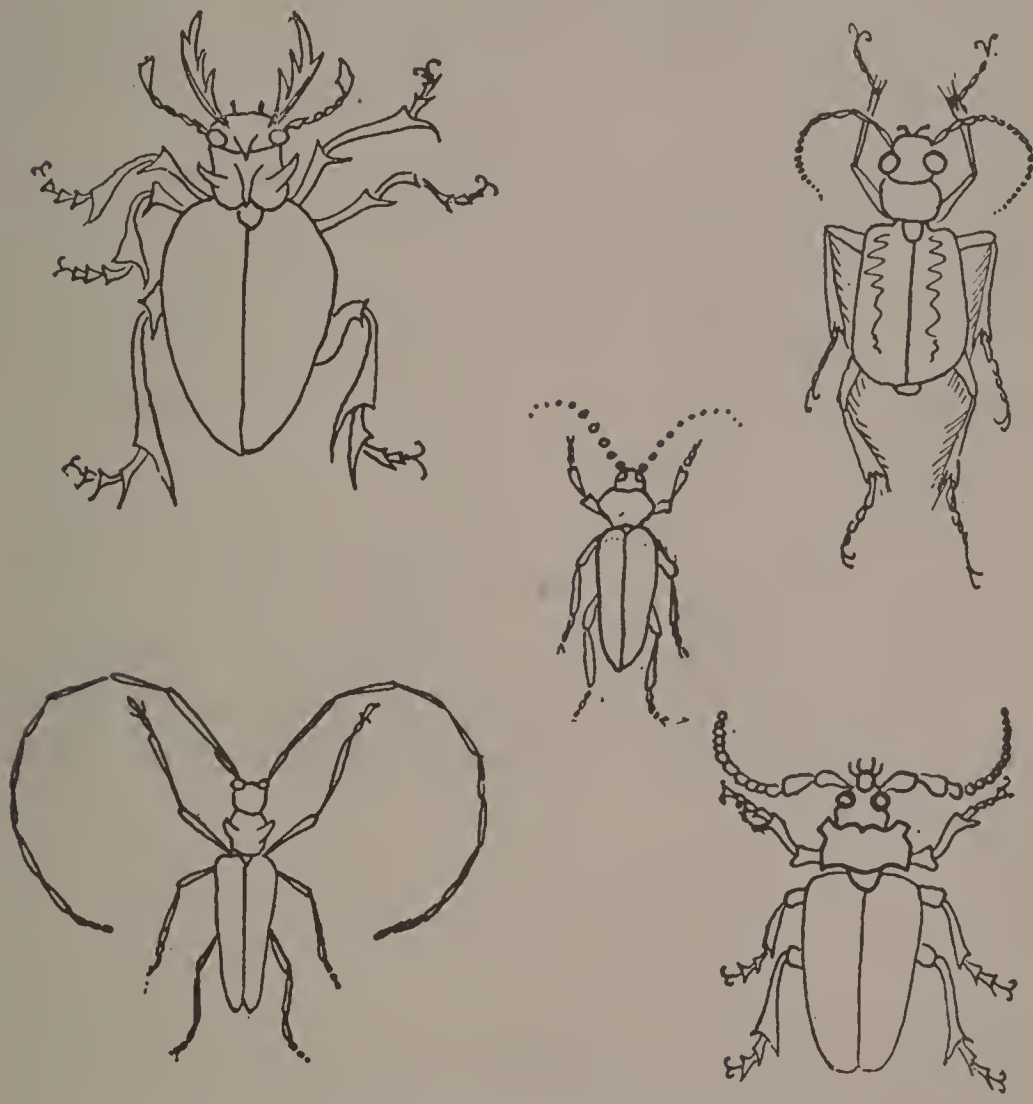

FIG. 14.—Some Long-horned Beetles.

2. The scarabs. These are the giants of the beetle creation. The sacred scarab of the ancient Egyptians and the giant scarab of South America are the most noted examples. This South American beetle is said to measure six inches in length

and nearly a foot across, from tip to tip, when the wing-covers are spread. The thorax is armed with a huge horn, as is also the head. This gives him a very formidable appearance. Many beetles of this family have horns, some of which are branching; hence, one species is called the stag-horn beetle.

3. Blister-beetles are remarkable in many ways chiefly on account of their many changes during development (hypermetamorphosis). These changes are too complicated to describe here. What is of especial interest to us is the use of these insects in medicine for producing blisters.

4. The Buffalo-beetle or "carpet-beetle" derives its names from having been first described in Buffalo, N. Y., where it was found injuring carpets. It may be got rid of by using benzine, gasoline, kerosene, hot water, corrosive sublimate (poison), or naphthaline.

CHAPTER VII.

Bugs.

ALTHOUGH in common parlance beetles are often called *bugs*, they are not true bugs. The true bug is as unlike the beetle in appearance as it is unlike

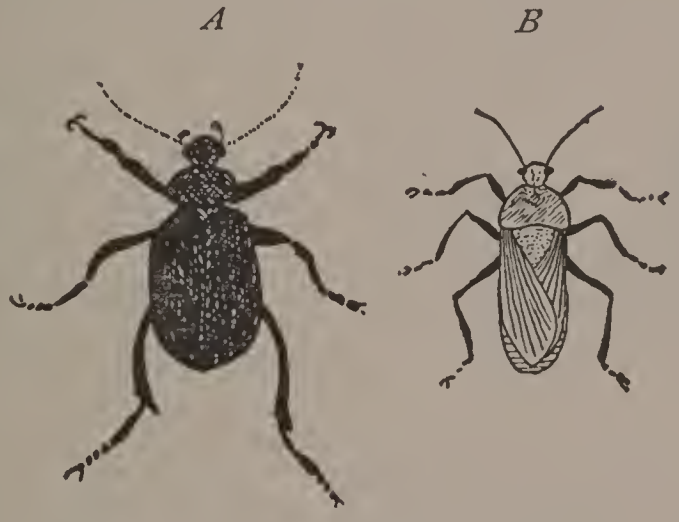

FIG. 15.—*A*, Beetle; *B*, Bug.

a bee or a fly. On comparing the figure of a bug with any of the preceding figures of beetles, it will be seen that there are several points of difference between them.

1. The first pair of wings attract attention. In the beetle these are hard and shell-like, unfitted for flight, but admirably suited to protect the hind

pair of wings when not in use. In the bug the first pair of wings is membranous, and when at rest they are folded back so that their tips overlap.

2. The second pair of wings also vary. In the beetle these perform the true act of flight. They are much larger than the first pair. In the bug, however, this second pair is much smaller, being about half the size of the front pair. Hence the name, Hemiptera, as applied to this order of insects.

3. The mouth-parts are also very different. In beetles these are fitted for biting, hence the parts—mandibles, maxillæ, etc.; but in bugs the mouth-

FIG. 16.—Types of Bugs.

parts have become fused together into a tube or proboscis suited for piercing and sucking juices from plants and animals. As the "June-bug" or May-beetle is a common type of beetle, so the squash-bug may be taken as a type of bug. Let specimens of these be collected for study and comparison.

There are several classes of bugs; but it is our intention to devote our studies to a few of the more familiar species.

THE SQUASH-BUG.

If the vines of summer squash be examined at any time between the first of July and the first of October, an abundance of squash-bugs will usually be found. These will be seen in every stage of their existence, from egg to perfect insect.

FIG. 17.–Squash-bug.

The squash-bug is a particularly good bug to begin with, on account of its abundance and its geographical range, for it is extensively distributed.

A close study of this bug will disclose the following facts:

1. The head is flattened, or better, it is narrow from right to left. The eyes are small, but prominent. There are also two ocelli. The head is connected to the prothorax by a short neck. The beak is sharp and slender.

2. The parts of the thorax are so fused together that it is not easy to see where they are united. The wings are usually folded so that their tips overlap across the lower portion of the abdomen. They are rarely used for flight. The squash-bug prefers to run about rather than to fly. This bug has glands which secrete a rank-smelling fluid which is used probably as a means of defense.

According to entomologists, these insects hibernate in crevices and other sheltered places but come out in June and shortly after lay their eggs and die.

These eggs are deposited on the under surface of the leaves of the squash-vine.

The eggs, larvæ, pupæ, and perfect insects may all be collected from squash vines early in the fall. It is then the best time to make collections. The larvæ and pupæ closely resemble the imagos in everything save the wings. Thus bugs are seen to be different from beetles in another respect, i.e., they do not undergo complete transformations as the beetles do. For this reason insects are often classified as belonging to two classes: (1) Those which undergo complete metamorphosis, and (2) those which undergo incomplete metamorphosis. The young of the former are called *larvæ*, those of the latter, *nymphs*.

THE CHINCH-BUG.

This is the enemy of our wheat crop. Vast quantities of this most useful grain are destroyed annually by this insect pest. The damage done in 1890 is estimated at four million dollars. It is a small beetle not much more than one tenth of an inch in length. The four wings are white. There is a peculiar symmetrical black figure on the back.

The female lays over 500 eggs on the ground and the larvæ hatch out in about two weeks. They attack the grain, and here they may be found all through the summer.

Chinch-bugs are abundant from the Atlantic coast to Kansas and Nebraska, and from Maine to the

extreme southern portions of the Mississippi Valley. The best way to check the increase of chinch-bugs is to burn the weeds and grasses surrounding the grain fields. This destroys vast numbers of eggs. The chinch-bug has at times been the cause of the destruction of three-fourths of the grain crop in some of our Western States; but it was killed off by an epidemic which swept off millions of them. Moist, cool, cloudy weather is very bad for their health.

THE CICADA AND THE HARVEST-FLY.

This is in many respects the most interesting species of this family. Its periodical occurrence once in about seventeen years, the damage it does

FIG. 18.—Cicada.

vegetation by laying its eggs upon it, and its wonderful vocal apparatus, make it one of the most interesting of insects for study.

The cicada is often called a locust, probably because of the vast numbers in which it appears. It is not a locust and differs materially from the locust in several particulars.

1. The head is broad and thin, beak very strong and sharp, eyes large and prominent, three ocelli.

2. The thorax is broad and hard, having a prominent shield on the back. The wings are beautiful membranous, having strong veins.

3. The abdomen is short and very broad. The whole appearance of this insect indicates strength.

4. Natural history: The eggs are laid on young shoots in incisions made by the peculiar scythe-shaped ovipositor. These eggs hatch into small white maggots which feed on the sapwood of the plant. Then they eat their way out and creep down the trunk to burrow in the ground. Here they remain for a long time. Some species require a year or two, others thirteen, fifteen, or even seventeen years to mature. The pupa then digs its way out of the ground by means of its very powerful claws, and creeps up the trunk of the nearest tree. Indeed they may be seen creeping up the stalks of grasses, weeds, and even up fence posts.

When firmly fastened to some thing they remain but a short time before the back splits open and out of the old pupa shell there comes forth a perfect imago. The wings are wet and all crumpled up, but they gradually spread and dry, and then the insect spreads its wings and flies away. Their life is short after this. Their "song" is heard, if the clatter they make can be called a song. Then they lay their eggs and die.

The organ with which the sound is made, is a very complicated one, quite as complicated and very much more delicate than the human larynx. The females are silent. The vocal organs are found only

in the males. They are on the under side of the abdomen and are covered with two rounded shields or scales that give the male cicada the appearance of wearing a vest. On lifting these scales a system of beautiful membranes as thin as a soap-bubble film and giving the same iridescent effects, will be seen. Just how this organ is played upon is not yet satisfactorily determined.

THE GIANT WATER-BUG (BELOSTOMA).

This curious insect is known as the "electric-light bug" in many places on account of its being found about the lights of cities in great numbers. An inspection of these curious creatures shows them to be predaceous in their habits, the fore legs being fitted exclusively for seizing their prey. Having seized it, they thrust their powerful beaks down into its quivering flesh and at once begin to suck out its juices.

FIG. 19.—Giant Water-bug.

The life-history of the Belostoma is not fully known. A few facts are, however, well established. The eggs of some of the members of this family are laid and fastened to the back of the female by means of a sort of glue which does not dissolve in water. The eggs remain there for some time before hatch-

ing. The American Belostoma lays its eggs on stones, reeds, and other submerged things near the shores of ponds where the soil is moist. There are large clusters of these eggs, often numbering as many as fifty or sixty, in a single cluster. They are said to be nearly a quarter of an inch long and spotted with brown.

The eggs are supposed to hatch in an almost perfect condition, and the nymphs, as they are called, creep into the water where they are believed to feed on larvæ of aquatic insects. They are supposed to moult several times and in the course of a year to develop a pair of perfect wings. After this, they live about the water by day and fly about at night. They dive with perfect ease and creep about on the bottoms of ponds in search of prey. Their dull brown color is very effective in protecting them, for when seen through the water they look not unlike dead brown leaves moved over the bottom by the movement of the water.

The Belostoma thrive well in aquaria where they dive and swim with the greatest ease. The larger species seize small fish and tadpoles and extract their juices. Thus the life of a pond is one never-ending tragedy.

"One vast, savage, grim conspiracy,
Of mutual murder, from the worm to man,
Who himself kills his fellow."—*Edwin Arnold.*

PLANT-LICE.

An examination of the leaves and stems of most herbaceous plants will usually disclose the presence

of numerous tiny creatures of a green or brown color to match the color of the plant on which they live. A further observation will disclose the fact that these tiny creatures are not all alike in

FIG. 20.—Willow Aphis.

shape or size, and also that some have wings, while others are destitute of these organs. These are aphides or plant-lice. They abound almost everywhere, and on this account as well as on account of their wonderful powers of propagation, they deserve careful study.

All that is needed for school study of the aphis is a good simple microscope or a magnifying glass with which to observe them. The drawings are very much enlarged and the little line beside each indicates the true size of the insect.

FIG. 21.

It is beyond the limits of this book to deal at all extensively with these very interesting creatures. Their life-history is exceedingly complex. There are two forms of plant-lice, the

winged and the wingless. Most of the females are wingless and most of the males are winged, but there are wingless males and winged females. The sex may be determined by the size of the bodies, the males having much smaller bodies than the females. Plant-lice spend the winter in the egg; at least this is true of the majority. These eggs hatch in the

FIG. 22.—Cherry Aphis.

spring, bringing forth wingless females. These produce large numbers of living females both with and without wings, and this goes on all summer. The last brood of the season are both males and females. The wonderful rapidity with which these creatures multiply makes it possible for a single pair of aphides to be the ancestors of many thousands of plant-lice in a single season.

One of the most curious traits of these insects is their behavior towards ants. Any observer will soon see ants creeping about wherever there are aphides. If watched, the ant will be seen to approach an aphis and touch the abdominal appen-

dages with its antennæ. The aphis will invariably yield a drop of clear, transparent honey which the ant will greedily devour. The plant-louse shows no sign of fear of the ant and the ant does not harm the plant-louse. There seems to be a perfect understanding between these widely different insects. This peculiar habit of ants and aphides has led people to call the latter "ant's cows."

THE SCORPION-BUG.

This remarkable bug is one of the aquatic species. It is also known as the "water-scorpion" and the "ranatra.'

This insect may be seen skimming over the surface of the water in summer. The body is very long and slender and the legs are very long indeed. The front pair of legs are modified so as to be used like the pincers of the scorpion, for seizing and holding prey. Hence the name, "water-scorpion." The abdomen has a pair of slender filiform appendages nearly as long as the legs. These are stiff and horn-like. They may be drawn close together so as to form a tube for they are grooved on the inner surface. The legs also are curiously grooved, so that the tibia can fit into

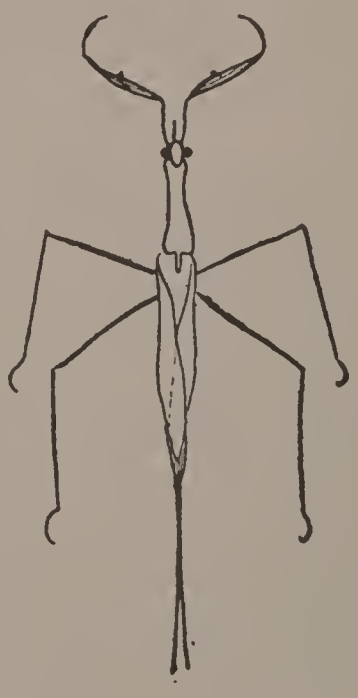

FIG. 23.—The Scorpion-bug.

the tarsal groove very much as a jackknife blade shuts into the hollow handle. Ranatras are able to skim backwards as well as forwards over the surface.

Packard says that the ranatra may often be seen walking over the bottom of some quiet pool, where it usually escapes observation on account of its protective coloring. When thus employed it is searching diligently for prey, as may be seen by the attitude of its head and powerful front legs. When the ranatra finds "game" to its liking, it is seized, and the hooks and sharp teeth on the forelegs help to hold it, while the sharp beak penetrates the quivering victim to extract its juices.

The water-scorpions are said to thrive well in aquaria, where their mode of life may be observed.

SCALE-INSECTS.

Many plants, especially orange, lemon, and the dwarf palms, so common as a decorative plant in our homes, are found to have oval brown scales upon their leaves and stems. These scales are female insects. If a scale be carefully raised with a knife-blade and the under surface be examined, there will be found an insect which appears to be in the larval state. It has no wings. Its legs are short and almost obsolete. There appear to be no antennæ. These females are sluggish and almost destitute of ability to move about.

The males, however, are very active. They have

wings and can fly with considerable rapidity. One or two may usually be found flying about a dwarf palm or other plant which is infested with these insect pests.

There is another species which excretes a pure white cottony substance. These are often seen on apple twigs in the late summer.

Plant-lice, scale-insects, and all other bugs live on liquid food extracted from the plants or animals on which they live.

It is easy to tell when a plant is infested with any of these parasites. The leaves turn yellow or brown in spots and finally drop off the plant. There are various "insecticides" which are designed to free plants of such vermin, but for small plants nothing is better than to wash the leaves with whale-oil soapsuds, and most plants can stand a bath of strong alcohol.

CHAPTER VIII.

The Locust Family.

THIS family includes the true locusts or Grasshoppers, the Katydids and crickets, the earwigs, walking-sticks, and roaches.

The family is very abundant everywhere, and their characteristics can be studied by all.

The most obvious characteristics are, (1) their straight wings or wing-covers, which are shaped like a parallelogram. The veins are also straight, resembling the venation of lily leaves. The hind wings are irregularly triangular in outline, and more or less gauzy. In some species these hind wings are black bordered with yellow; in others both pairs of wings are obsolete or entirely wanting. (2) The hindermost legs (metalegs) are much larger and longer than either of the other legs. In some members of the family these legs are several times larger than the others, and are specially fitted for jumping.

THE GRASSHOPPER AND KATYDID.

These are the true locusts, or *Locustidæ*, as entomologists call them. They are so familiar as to need only passing mention.

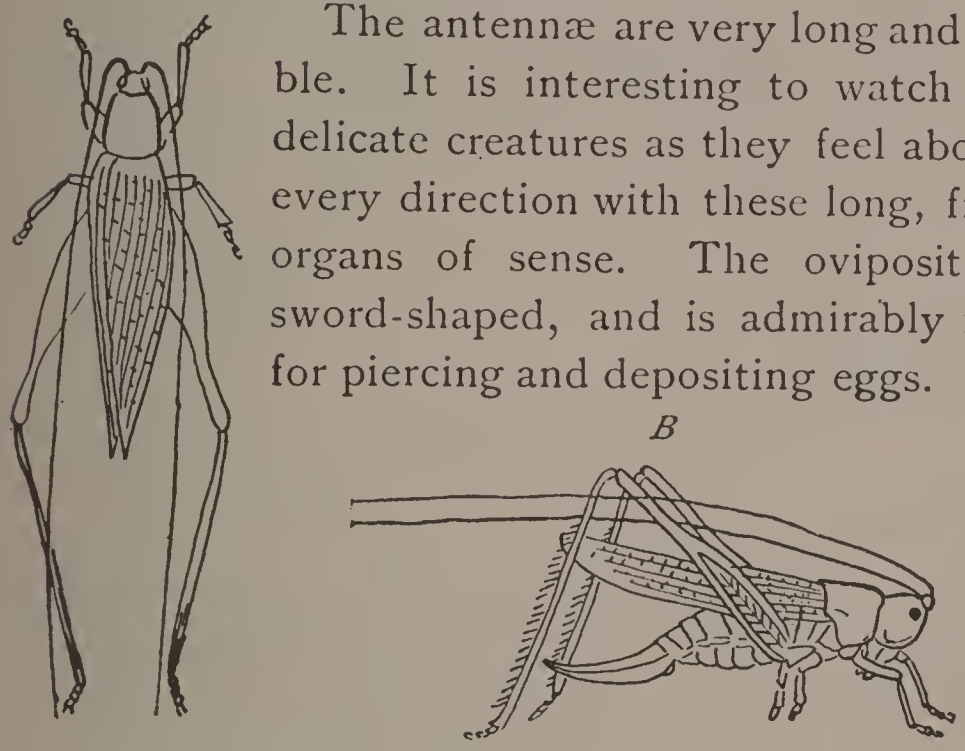

FIG. 24.—*A*, Katydid ; *B*, Grasshopper.

The antennæ are very long and flexible. It is interesting to watch these delicate creatures as they feel about in every direction with these long, fragile organs of sense. The ovipositor is sword-shaped, and is admirably fitted for piercing and depositing eggs. The wings are large and membranous and very delicately veined.

The Grasshoppers and Katydids are well protected by their colors. The former, by their gray or brown color, are hidden when they alight upon the ground, while the latter by their green, leaf-like wings can scarcely be distinguished from the leaves on which they are found feeding. On close examination the outer wings (wing-covers) of the Katydid so closely resemble a leaf in veining and texture that they may be often taken for leaves when held in the hand. The small brown and gray Grass-

hoppers are often known as "dust hoppers" from their familiar habit of hopping along dusty road-

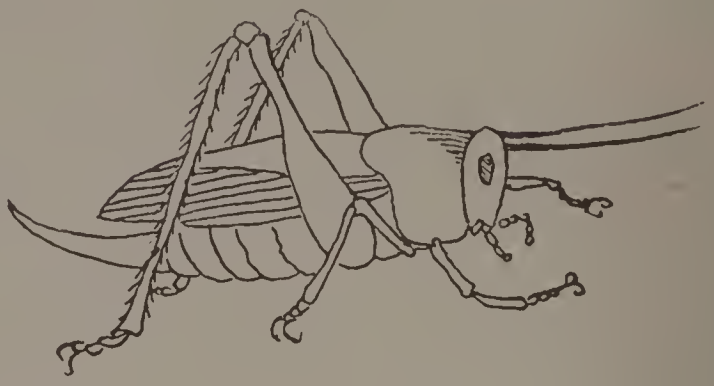

FIG. 25.—Locust.

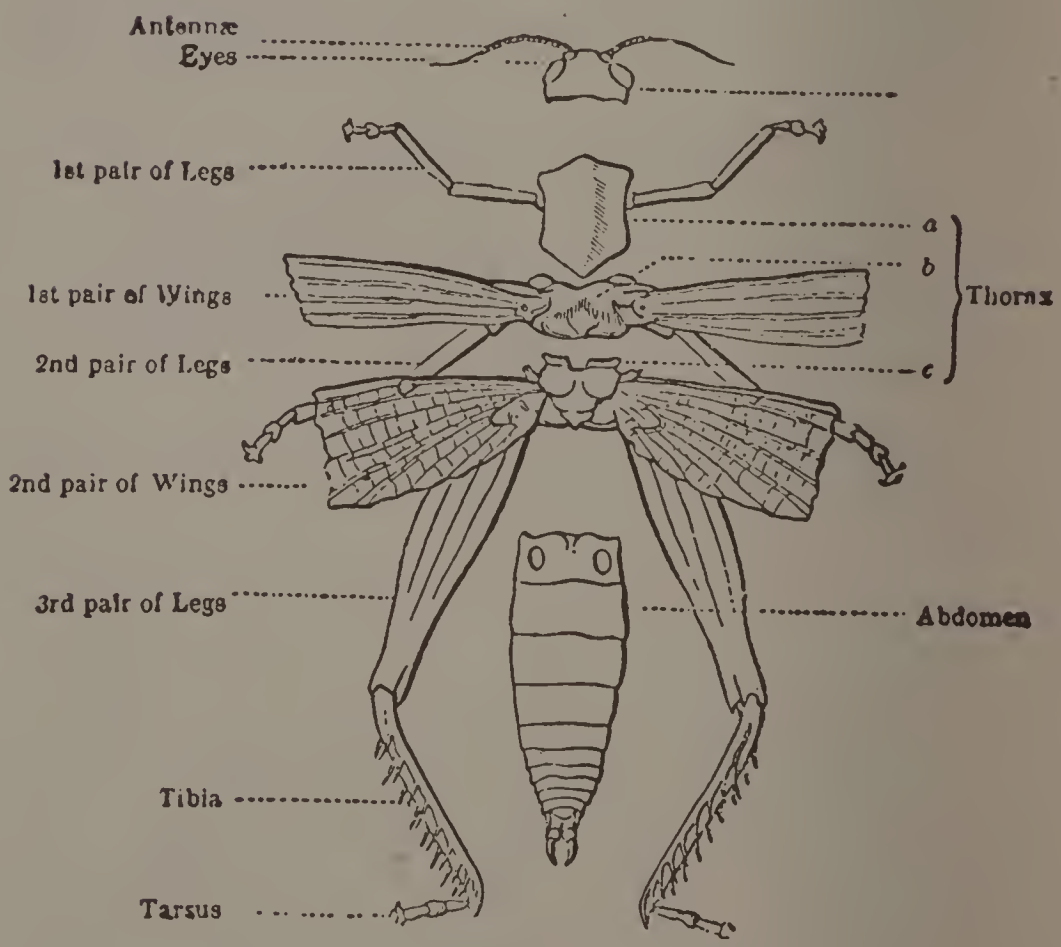

FIG. X.—Parts of a Grasshopper.

ways in summer. These are very easily seen as they spread their black, yellow-bordered under-

wings, but when they alight and fold their wings beneath their dust-brown wing-covers, it is not easy to see them.

The diet of these insects is vegetable food. In some places they become a great pest, often devouring the entire crops in our western states; but in general they are not to be considered as harmful.

The noise of these creatures is produced by drawing the long hairy tarsus across the wing when expanded. There are numerous rough processes on the wing-veins which, being caught by the tarsal barbs, cause a rapid vibration of the wing membrane. This produces the familiar chirp of crickets and the well known "Katy did, Katy did" so often heard on summer evenings.

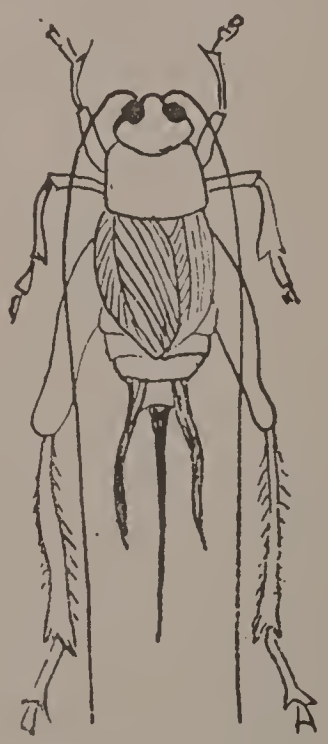

FIG. 26.—Cricket.

CRICKETS.

The crickets have much shorter bodies than those of the Grasshoppers and Katydids. The family resemblance it very strong however. The long antennæ and large hind legs are characteristic of the family, but in the crickets the wings are far shorter than in the locustidæ.

The front legs are relatively stronger. This is because the cricket spends so much of its life digging under stones. Indeed, the mole-cricket, as it is called from its subterranean mode of life, has the

fore legs remarkably developed, like the corresponding limbs of its namesake, the mole. The last ring of the abdomen bears a long, slender ovipositor, and the ring preceding is armed with two slender-pointed organs called abdominal *setæ*.

Crickets feed on roots, tender shoots, and also on larvæ and worms. They may always be found creeping on the ground among tall weeds and grasses

FIG. Y.—Young Cricket.

and under flat stones which have lain for a long time upon the ground.

The chirp of the cricket is a familiar sound on summer evenings in the country and also in old houses. Hence the ancient rhyme:

"Old Dame Hicket
Had a wonderful cricket
That lived in a hole by the fender
And when he came out,
He would dance all about
On his hind legs so tall and so slender."

THE WALKING-STICK.

This is one of the oddest of all insects. There is something weird and uncanny about it.

It is rightly named for it very closely resembles a stick. When seen, it may easily be passed by as a dry, dead twig. In barns these creatures may often be seen among the hay looking precisely like pieces of dead grass. This imitation is carried out further in the fact that in spring when everything is green, these creatures also are green; but later in the season when vegetation is taking on a different hue, they also change color and assume dull gray or brown. In movement they are very slow, so slow that one must watch them constantly and for a long while to see that they have moved at all. But this slowness of movement is part of their protection against enemies. They can move with great rapidity when they like and often are found to be very difficult to catch.

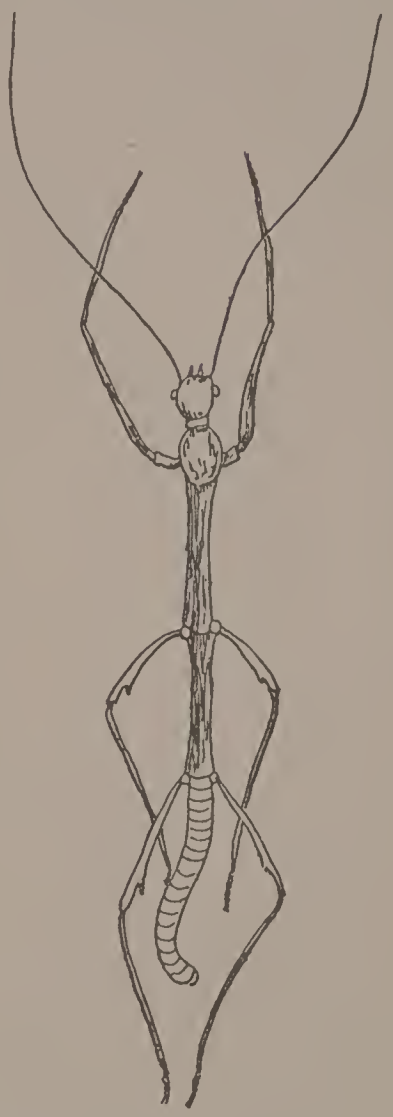

FIG. 27.—Walking-stick.

The thorax is not fused into one segment but

consists of three distinct rings of very unequal size. The first ring (prothorax) is smallest. There are no wings or rudiments of wings. The eyes are small and antennæ very long. The mouth is fitted for biting vegetable food. The feet are very similar to those of the Grasshopper and Katydid.

THE ROACH.

Roaches are common about mills and in houses, especially in pantries and kitchens. They run with great rapidity and hide in very narrow cracks and crevices. The structure of their bodies especially adapts them to creep into very small holes. The rings of the abdomen are capable of great expansion and contraction. The eyes are very small, antennæ very long, and mouth-parts fitted for biting. The roach is omnivorous. He eats vegetable and animal food and does not object to eating paper, clothing, and carpets. Hyatt quotes from travellers in tropical regions that roaches have been known to attack a sleeping traveller and nibble at his toe-nails.

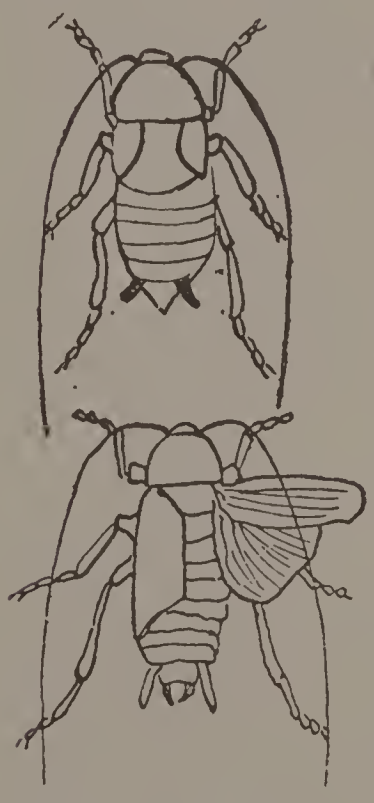

FIG. 29.—Roaches, male and female.

Roaches seldom, if ever, use their wings which are small in the males and almost obsolete in the females.

The female lays her eggs in two rows in a sac which she fastens to her abdomen. She carries this about with her until the young are hatched. It is said that the mother roach broods her young but how this is known I am not prepared to state.

The roach is very interesting from its great geographical range; it is found wherever any insect is found. It is also interesting because of its ancient descent; fossil roaches having been found in rocks of the Carboniferous Age.

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